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### Lesson Study

Roorda, Gerrit; de Vries, Siebrichje

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# Lesson Study: does it affect activating behaviors of mathematics teachers?

WALS, September 2016

Gerrit Roorda [g.roorda@rug.nl](mailto:g.roorda@rug.nl) & Siebrich de Vries [s.de.vries@rug.nl](mailto:s.de.vries@rug.nl)  
University of Groningen, the Netherlands

## **abstract**

*This study explores the effects of Lesson Study on activating teaching strategies of mathematics teachers in the context of an interschool Professional Learning Community in The Netherlands. In Lesson Study research, effects are mostly reported based on self-reporting. In a case study of three advanced beginners (3 – 6 years of teaching experience), we explored the effectiveness of Lesson Study by using a mixed-method of observations and teacher self-reports by means of interviews and questionnaires. Results indicate that two of three teachers report effects on their teaching. For one of those two teachers the self-reported effects were also observed. The third teacher does not report effects, nor were effects observed. Lesson Study seems to affect activating teaching strategies of mathematics teachers, but not in all cases.*

## **1. Introduction**

For twenty percent of the teachers in Dutch secondary education activating teaching is problematic (Van de Grift, Van der Wal & Toorenbeek, 2011), mainly for ‘advanced beginners’ (Berliner, 2001). Activating teaching is important because it makes pupils learn more effective (e.g., Hattie, 2012). In the present study, activating teaching (AT) is the main research topic. AT focuses on teaching strategies in relation to pupils’ active participation in mathematics lessons (Bolhuis & Voeten, 2001). This is observed for example when the teacher is asking questions, paying attention to pupils’ responses, giving feedback, stimulating pupil interaction, and instructing pupils to work on their own or on collaborative and co-operative tasks (Bolhuis & Voeten, 2001).

To contribute to AT, we chose Lesson Study (LS) as its professionalization approach. The context is a professional learning community (PLC) for teachers of mathematics. In LS, teachers collectively design and plan a so-called research lesson in great detail according to a collaboratively determined educational goal. Subsequently, they observe the designed research lesson with a focus on the pupils. Afterwards, they share their observations, revise and reteach the research lesson (e.g., Lewis, Perry, & Murata, 2006). LS includes activities which all have been proven to be effective for professionalization of teachers (Kooy & Van Veen, 2012). Research shows that LS can be a powerful means for teachers to improve their teaching practice (Cheung & Wong, 2013; Xu & Pedder, 2014). However these conclusions are mostly based on self-reports in small, qualitative research (Cheung & Wong, 2014; Xu & Pedder, 2014). Therefore, we explore the effectiveness of LS in a case study of three advanced beginners using a mixed-method of self-report (teacher interviews and teacher

questionnaires) and classroom observations. The main research question is: To what extent does LS affect advanced beginners' AT in regular math lessons in the Dutch context?

The main research question in this study has been subdivided in the following research questions:

1. What do teachers report on what they learned from LS after one year?
2. Which effects on AT do we observe in regular mathematics lessons after a year?
3. To what extent are self-reported effects observable?

## **2. Method**

### **2.1 Context and participants**

The research takes place in the context of a PLC for teachers of mathematics, a three-year pilot project (2014 – 2017) launched by the Dutch Ministry of Education. The PLC consists of 16 teachers from 10 secondary schools. The distribution of male and female teachers is 9 versus 7, the average age is 43 years ( $sd = 11$ , range = 27 – 59), the average teaching experience in years is 17 ( $sd = 11$ , range = 3 – 37). 11 teachers are fully qualified, and five teachers have a qualification to teach junior forms of secondary education. The teachers performed LS in three teams. In these teams advanced beginners collaborate with experienced teachers.

In this paper we present a case study of three advanced beginners, Susan, Max and John. They have respectively 3, 6 and 5 years of teaching experience. Susan, Max and John participated in the same LS team. In the first cycle the LS team consisted of six persons, and in the second cycle of five persons. All teachers of this team had a qualification to teach in junior forms of secondary education. Data presented in this paper are collected from September 2014 – September 2015.

### **2.2 LS intervention**

In school year 2014-2015, two LS cycles took place. The general theme was activating students in mathematics lessons. Teachers were supported by two subject pedagogy teacher educators, who among other things provided literature on the theme, e.g. a still relevant book of Johnson (1982). The mathematical theme of the research lessons in cycle 1 was ratio-tables in grade 10. To activate pupils, they had to work in small groups on ratio-tasks situated in several contexts (such as calculating percentages, scale, average velocity and density). Pupils had to discover relationships between the solution strategies of different tasks. After the small group work the teacher discussed the similarities between the tasks in interaction with the pupils. In the post lesson discussion the LS team concluded that many pupils were active in small group work. However, pupils found it difficult to discover and explain deeper similarities between the tasks.

The theme of the research lesson in cycle 2 was 'similar triangles' in grade 9. In this lesson pupils had to discover when triangles are similar. The LS team focused on the difference between meanings of the word 'similar' in spoken language and mathematical language. To activate the pupils, in this lesson they had to work in pairs. Pupils had to describe features and properties of similar triangles, without any explication on 'similarity' beforehand. Afterwards, the teacher summarized the definition and properties of similar triangles on the white board.

In the post-lesson discussion teachers firstly concluded that is important to pay attention to differences between spoken language and mathematical language. Secondly, teachers noticed that the pupils were more curious because they had to discover the properties of similar triangles by themselves.

### **2.3 Data collection and instruments**

In this study, we used different research instruments: questionnaires and interviews (self-report), and observations.

*Questionnaires:* After each LS cycle, teachers filled out an evaluation questionnaire including some questions about learning effects. Teachers could indicate on a five-point rating scale whether an item was applicable to them or not. Items were, for example increased knowledge of subject matter, increased knowledge of instruction, increased ability to observe pupils, increased understanding of pupils' thinking and learning and improved quality of lessons.

*Interviews:* The teachers were interviewed at two times:

- (1) A post-observation interview: after the observation of two regular math lessons, the observer conducted a tape-recorded interview during approximately 20 minutes. Questions focused on choices of the teacher to activate pupils in the observed lessons. The interviewer also asked which teaching behaviors are a result of experiences in the LS project.
- (2) An evaluation interview: after the second LS cycle teachers were interviewed by telephone to collect additional data related to learning effects. Transcripts were made of both interviews.

*Observations:* Since we aimed at a detailed description of teaching behavior, we took the approach of observations to record all teacher behaviors connected to AT during a lesson. Because of this intensive way of data collection, we chose to observe two lessons per teacher conform Bolhuis and Voeten (2001). When arranging dates for the observation with the teacher, the teacher was asked to teach math lessons as 'regular' as possible.

The entire lesson, which lasted 45 to 50 minutes, was video-recorded. During the observation, the observer completed a Narrative Running Record (Smith, Baker, Hattie & Bond, 2008) on AT, a semi-structured form for recording, at 5 min intervals of as much classroom activity and interaction as possible. The observer also described the whole class activity and from three randomly chosen pupils their on- or off-task behaviors.

In this way two lessons of each teacher were observed in September 2014 and after the two LS cycles in June 2015 for Susan, in September 2015 for Max and John. For Susan the pre- and post-LS observations were in the same classes; only one post-LS lesson has been taken under consideration, because one of the post-LS lessons turned out to be not a regular math lesson. For Max and John the post-LS lessons were in other classes, because of changes in the school schedule after summer holiday.

## 2.4 Data analysis

*Interviews and questionnaires:* Based on the questions about learning effects in the evaluation questionnaire and the interviews, a survey was made of the learning experiences, moments and subjects and the eventual impact on teaching practice.

*Observations:* For AT an analysis instrument has been constructed including 25 activating behaviors (based on Ebbens and Ettekoven, 2013) connected to three teacher roles of instructor, question asker and coach. Furthermore, a detailed scoring rubric was developed, based on a three-point scale (Schoenfeld, 2013). Level 1, 2 and 3 describes performances that are characteristic, respectively for low, average and high performances on that dimension. Also for the observations of the whole class activity and of the on- or off-task behaviors from three randomly chosen pupils a scoring rubric was developed. Each lesson stage subsequently was scored on AT. Codes of pre-LS observations were discussed among two researchers. Finally, an ‘average’ score per lesson was calculated. This average score provides information on the level of AT of a teacher. In addition to these analyzes, we verified if self-reported effects could be identified in the recorded lessons.

## 3. Results

### 3.1 Susan

#### *Questionnaire and interviews*

Table 1 presents some results of the evaluation questionnaire concerning the effects of participation in a LS team. After both LS cycles, Susan indicates increased knowledge of instruction, increased ability to observe pupils and increased understanding of pupils’ thinking and learning. After the second LS cycle, Susan adds improved quality of lessons.

**Table 1.** Results of the evaluation questionnaire of Susan

	<i>After cyclus 1</i>	<i>After cyclus 2</i>
Increased knowledge of subject matter	2	3
Increased knowledge of instruction	4	5
Increased ability to observe pupils	5	4
Increased understanding of pupils’ thinking and learning	4	5
Improved quality of lessons	3	5

1 = totally not applicable; 5 = fully applicable

In the evaluation interview Susan reports learning experiences in several domains. Firstly, the domain of lesson organization: time, pace and structure of the lesson. Susan says:

*“I now increase the pace of my lessons. I notice that I urge the pupils by reminding that an activity should be completed in five minutes. Previously I was more relaxed, waiting for the moment pupils finished an activity. The pace of the lessons was more guided by the pupils. [...]. Now, I’m just, um, more structured.”*

Secondly, Susan reports that she is now trying to be more precise in using mathematical language. She says that she was used to mix spoken and mathematical language. This effect is not directly related to AT, but, it is mentioned several times by Susan. Thirdly, Susan says she

is now more consciously preparing and reflecting on her lessons and experimenting with other approaches.

### *Observations*

Table 2 describes the results of the observations. The level of AT increased from 1.8 to 2.2, and the pupils were more active after two LS cycles (see Table 2).

**Table 2.** Observations of Susan

	<i>Before</i>	<i>After two LS cycles</i>
Activating teaching	1,8	2,2
Pupils' activity	2,2	2,7

Before the start of the first LS cycle, Susan gave her pupils a task without any indication of the time that pupils were allowed to spend on it. Some pupils finished quickly, other pupils needed more time. In the meantime, Susan walked around and helped several pupils who had questions. After she had noticed that almost everyone had completed the task, she explained how the task could be solved.

After the two LS cycles, Susan organized her lesson differently: she divided the lesson in small activities with a clear time indication. A typical statement is: “*What I want from you, and you now get five minutes, is that you measure all angles of the pie-chart. Five minutes.*” In the meantime, Susan walked around and encouraged the pupils to work. Susan scored this time many AT indicators, and pupils were visibly active. This way to activate pupils is in line with Susan’s statements in the evaluation interview. This kind of behavior also seems to be an effect of Susan’s experiences in her LS team.

### *Summary Susan*

Susan reports that her experiences in two LS cycles mainly affect the pace of her lessons and her use of mathematical language. She gives examples that were also observed in her regular lessons. The level of AT increased, mainly due to an increased pace of the lesson and the variation in explanations and short assignments for pupils.

## **3.2 Max**

### *Questionnaire and interviews*

Table 3 presents the results of Max’s response to the questionnaire.

**Table 3.** Results of the evaluation questionnaire of Max

	<i>After cycle 1</i>	<i>After cycle 2</i>
Increased knowledge of subject matter	2	3
Increased knowledge of instruction	2	3
Increased ability to observe pupils	3	3
Increased understanding of pupils’ thinking and learning	2	3
Improved quality of lessons	2	3

1 = totally not applicable; 5 = fully applicable

In the observation interview, Max does not mention spontaneously changes in his teaching behavior as a result of his participation in a LS team. After the interviewer asks the question,

Max remains silent for a while, and says: “*Difficult question [...] I think my lessons stay the same in general. But I think about things [...]. We spoke about the use of language, perhaps I can use that more in my lessons*”

In the evaluation interview, Max states that collaboration with mathematics teachers of different schools is a strong aspect of LS. However, he also mentions that LS was time-consuming in relation to the personal benefits. He would prefer it more efficient and practical.

#### *Observations:*

Table 4 presents the results of the observations of Max’s lessons. The level of AT is nearly the same. However, pupils were more active after the two LS cycles.

**Table 4.** Observations of Max

	<i>Before</i>	<i>After 2 LS cycles</i>
Activating teaching	2,2	2,1
Pupils’ activity	1,9	2,5

Before and after the two LS cycles, the level of AT is nearly the same. However, the lessons were quite different in structure. In the lesson before LS started, the pupils worked a long time on one problem. During problem solving, the teacher often simplifies the problem by dividing it into smaller steps and explaining parts of the solution.

After the two LS cycles, the teacher started with a brief introduction. Then pupils worked independently for a while. The teacher constantly checked whether pupils were working or not. At a certain moment, pupils had to work for 10 minutes independently and in silence. This led to increased activity in the classroom, and most pupils worked concentrated in their notebooks. This resulted in a higher level of pupils’ activity after the two LS cycles.

#### *Summary Max*

Max reports neutrally in the questionnaire about the gains of LS. He does not mention concrete examples of changes in his teaching behavior. He is positive about some aspects of LS, such as collaboration with colleagues from other schools. The observed lessons have nearly the same level of AT.

### **3.3 John**

#### *Questionnaire and interviews*

Table 5 presents John’s response to the evaluation questionnaire concerning the effects of participation in a LS team.

**Table 5.** Results of the evaluative questionnaire of John

	<i>After cycle 1</i>	<i>After cycle 2</i>
Increased knowledge of subject matter	2	3
Increased knowledge of instruction	4	5
Increased ability to observe pupils	5	5
Increased understanding of pupils’ thinking and learning	5	4
Improved quality of lessons	3	3

1 = totally not applicable; 5 = fully applicable

After both LS cycles, John indicates increased knowledge of instruction, increased ability to observe pupils and increased understanding of pupils' thinking and learning. In the interviews John reports effects in three domains. The first self-reported learning effect is the use of a tight schedule: *"It worked pretty well, with short periods of working time for the pupils"*. Secondly, John reports that he is now experimenting with small group work in the context of a mathematics project.

A third learning experience is related to the use of mathematical language. John says: *"In my lessons, I am also working on using mathematical language; for me this theme was an eye-opener"*. However, he is not able to give concrete examples of changes in his language use.

### Observations

Table 6 shows that John is making some progress on AT and that the pupils are more active in the lessons observed.

**Table 6.** Observations of John

	<i>Before</i>	<i>After 2 LS cycles</i>
Activating teaching	1,5	1,8
Pupils' activity	1,5	1,8

Before the start of the first LS cycle, John is explaining a mathematical topic while the pupils are listening. John is hardly questioning pupils and pupils are not involved in classroom discourse. Some pupils finish their mathematical tasks quickly. From that moment on they are no longer actively engaged in mathematics. John shows little indicators of AT.

After the two LS cycles, we observe that John is asking questions and is discussing some mathematical topics in one of the two classes. However, in the other class the pupils are a bit noisy and John has trouble to keep their attention. Thus, we did not observe a tight time schedule.

Besides, we observed some concrete changes in John's behaviors. For example, at a given moment John asks a question to one pupi, but then, after a short pause, he asks the question to the whole class: *"Thomas, can you tell me when, wait, who can tell me when we use this formula"*. Such a change can be an effect of his participation in the LS team, because this kind of questioning had been discussed in his team. Another change is that John now activated pupils during his explanation: they had to work first on a small task, before John continued his explanation.

### Summary John

John reports that the LS cycles did affect his teaching behavior. He mentions that he is using a tight time-schedule now and that he is thinking about mathematical language. However, we observed no examples of this changed behavior in the lessons observed. The scores on AT after the two LS cycles are slightly higher. This is mainly because John is asking more questions during his explanation to involve the class in the mathematical discourse.



## Conclusion and discussion

In this study we explored the effectiveness of LS in the Netherlands in a multiple case study of three advanced beginners using a mixed-method of observations, teacher interviews and teacher questionnaires. The main research question is: To what extent does LS affect the AT of advanced beginners in regular mathematics lessons in the Dutch context?

In this case-study two of three teachers (Susan, John) report effects on their teaching behavior. For one teacher (Susan) the self-reported changes are also observed in the post-observation. We observed small changes in teaching behavior, such as an increased pace of the lesson. The second teacher (Max), was positive about his participation in a LS team, but he did not report changes in his teaching behavior. For the third teacher (John), the self-reported effects were not observed, but his lessons were a bit more activating in the post-observation. Susan and John also report effects which were not observable, such as experimenting with group-work and increased understanding of pupils' thinking and learning.

Our conclusion is that LS in the Netherlands can contribute to small changes in teaching behavior, but that this does not hold for all teachers. Although this way of professionalization is close to educational practice, the translation to every-day-teaching practice is difficult. More in general, it is known from the teacher change literature that change in teaching behavior is possible, but that it is very difficult to achieve, and that you need a change in both teaching practices and teacher beliefs (e.g., Clarke & Hollingsworth, 2002; Desimone, 2009). In addition, for such a change the didactical contract (or socio mathematical norms) (Brousseau, 1990) an implicit agreement about the communication in the classroom, needs to be changed, which also is difficult. At the other hand, we should be happy with small changes. Teaching is a cultural activity (Stigler & Hiebert, 1999), and cultures change gradually and steadily. Teaching then can only change gradually (Lewis, Perry & Hurd, 2009).

This study has also several limitations. We investigated only three teachers before and after two Lesson Studies. The generalizability of the results of a case study is an important issue (Lincoln and Guba 2000;; Yin 2014). Lincoln and Guba (2000) argue that, on the one hand, case studies contain factors that are unique to the studied context, and which cannot be generalized. On the other hand, they suggest that case study results are working hypotheses, which are transferable to some extent. The description of these three cases can contribute to a greater understanding of how self-reported effects are related to every day teaching. It is our intention to expand this study with advanced beginners but also proficient teachers, and to monitor them during two years (four Lesson Studies).

A second limitation is, though scoring of the teacher observations has been discussed among two researchers, this scoring can be improved for example by using interrater reliability.

A third limitation is the representativeness of the observed lessons. Are these lessons really 'regular' lessons, or do the teachers adapt their lessons because of the presence of an observer? And, are two lessons sufficient to measure AT. Praetorius et al. (2014) conclude that one lesson per teacher suffices to measure classroom management and personal learning support, whereas nine lessons would be needed for cognitive activation. Our indicators of activating teaching are partly related to the aspect 'classroom management'. So we can

assume that, based on the observed two lessons, we can get a clear picture of AT. But at the other hand some indicators are more related to the aspect 'cognitive activation'. To measure cognitive activation we should observe more lessons. In future research we would like to include cognitive activation in our observations.

A final limitation is that we have not taken into account data on the intention of the participants and of the process of a LS team. More information on Max's intention and motivation could possibly give insight in why he does not report any learning effect.

Additionally, analyzes of conversations of a LS team, when preparing or evaluating a research lesson would give information of the contributions of the different participants and the collaboration within the LS team and thus provide background information for observed changes.

Although this study has some limitations, we hope to contribute to the building up of case-based records of contextualized understandings of LS which is a necessary prior stage before subjecting the effectiveness of LS to summative test (Lewis et al., 2006; Xu & Pedder, 2014). Once the value of LS for contributing to activating teaching in the Dutch context should be determined, this could have important implications for both educational and professionalization practices in the Netherlands.

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